

## **REMARKS**

### **Amendments**

Claim 11 is amended to correct many typographical errors, delete unnecessary words, and to recite that in the selective hydrogenation step (a1) the hydrogen to feedstock ratio is 8 -30 liters of hydrogen per liter of feedstock. See, e.g., page 13, lines 18-19. See also the amendments to claims 18, 25-27 and 29-30. Claims 25-27 are also amended to refer to step (a1) or step (a2) in step (b). See, e.g., page 4, lines 19-25.

Claim 13 is amended to recite the function of the catalyst treatment. See, e.g., page 5, lines 4-7. Claim 15 is amended to clarify the language.

New claims 34-45 are directed to further aspect of the invention which are supported throughout the disclosure. See, e.g., the original claims, the Figure, page 5, lines 19-24, and page 10, lines 8-22.

New claim 46 is similar to the prior version of claim 11.

### **Rejection under 35 USC §103 in view of Carruthers et al. and EP '126**

Claims 11, 12, 16-19, 21, 23-25, and 28-33 are rejected as allegedly being obvious in view of Carruthers et al. (US 3,691,066) and EP 0 725 126. This rejection is respectfully traversed.

Carruthers et al. discloses a selective hydrogenation process wherein a hydrocarbon feedstock containing diolefins, mono-olefins, aromatics and sulphur compounds is used. The diolefin content is 4-35% by weight and the sulphur content is 0.01-1.5% by weight, in which 10-300 ppm by weight of the sulphur content being mercaptan sulphur. In the selective hydrogenation, the feedstock along with hydrogen is passed over a supported nickel catalyst. At a temperature of 50-250°C, a pressure of 200-3,000 psig, a space velocity of 0.2-10 v/v/hour and a hydrogen treating rate of 1,504 to 37,600 mol/m<sup>3</sup>. The resultant product is said to exhibit a reduced diolefin content of below 0.5% by weight and a reduced mercaptan content of below 30 ppm by weight, preferably below 10 ppm by weight. It is disclosed that the feedstock can be hydrogenated over a nickel catalyst without significant sulphur poisoning and that this finding is

believed to be due to the mercaptans reacting with olefins during hydrogenation to yield thiophenes. See Column 2, lines 19-53.

Thus, Carruthers et al. simply discloses a selective hydrogenation of hydrocarbon fraction which contains diolefins, mono-olefins, aromatics and sulphur compounds. Carruthers et al. make no disclosure or suggestion of subsequent treatment of the effluent from the selective hydrogenation such as by subjecting the effluent to a separation step to provide at least three fractions, a light fraction, a heavy fraction and at least one intermediate fraction. Similarly, Carruthers et al. provides no suggestion of subjecting a heavy fraction from the effluent of the selective hydrogenation to a catalytic procedure whereby sulphur compounds are at least partially decomposed or hydrogenated.

Moreover, there is no suggestion of treating an intermediate fraction derived from the effluent of the selective hydrogenation to a procedure whereby sulphur and nitrogen are removed. Carruthers et al. also do not disclose or suggest combining any of the fractions, let alone at least two fractions, derived from the effluent of the selective hydrogenation, wherein at least one of the fractions is desulphurized.

Carruthers et al. also is also devoid of any suggestion of subjecting the effluent from the selective hydrogenation to a procedure whereby the effluent is contacted with the catalyst to decompose sulphur compounds. Compare Applicant step (c2). Finally, Carruthers et al. provides no disclosure or suggestion of treating a feedstock which contains nitrogen and acetylenic compounds.

Further, as noted above, the hydrogen treating rate in the process of Carruthers et al. is  $1504\text{--}37,600\text{ mol/m}^3$ . This corresponds to 36-902 liters hydrogen per liter of feedstock. Compares, e.g., Applicants' claim 11.

Shigeto et al. (EP '126) discloses a process for hydrodesulfurizing catalytically cracked gasoline, which contains sulphur compounds and olefins, whereby the sulphur compounds are removed and reduction of the olefin content is minimized. In the process, the catalytically cracked gasoline feedstock is separated into a plurality of fractions (e.g., by distillation). At least one of these fractions is a fraction is rich in sulphur compounds that are hard to desulfurize. A second fraction is rich in sulphur compounds that are easy to desulfurize. At least one of these

first and second fractions is then subjected to catalytic hydrodesulfurization (e.g., using a nickel-cobalt-molybdenum catalyst). Thereafter, the hydrodesulfurized fraction is combined with the remaining fractions. See paragraph bridging pages 2 and 3.

EP '126 lists thiophene and alkylthiophenes as sulphur compounds that are difficult to desulfurize. Conversely, EP '126 lists benzothiophene, alkylbenzothiophenes, thiacyclopentane, and alkylthiacyclopentanes as sulphur compounds that are easy to desulfurize. At page 3, lines 36-50, the EP '126 disclose the boiling points of numerous sulfur compounds that are difficult to desulfurize and numerous sulfur compounds that are easy to desulfurize. As noted by EP '126, these boiling points are often close together. For this reason, EP '126 state that it is necessary to first determine the sulfur compound distribution and then select an appropriate distillation system.

The fraction that is rich in sulphur compounds that are hard to desulfurize contains more than 50 mol % of such sulphur compounds, based on the total content of sulphur compounds in the fraction. Conversely, the fraction that is rich in sulphur compounds that are easy to desulfurize contains more than 50 mol % of such sulphur compounds based on the total content of sulphur compounds within the fraction.

In Example 1, the gasoline is divided into seven fractions or cuts, which were analyzed. The 70-80°C cut and the 80 +°C cut had high contents of a sulphur compounds characterized as hard to desulfurize. These two cuts were combined together, subjected to hydrodesulfurization, and then combined with the remaining cuts. See also Example 2.

In Example 3, the feedstock was distilled into 20 cuts. The cuts were subjected to analysis and it was determined that four cuts had high contents of sulphur compounds characterized as easy to desulphurize. These four cuts were combined, subjected to hydrodesulfurization, and then combined with the remaining cuts.

In Example 4, the feedstock was again divided into 20 cuts. Four of these cuts were found, following analysis, to have high contents of sulphur compounds characterized as easy to desulfurize. In addition, other cuts were found to have high contents of sulphur compounds characterized as hard to desulphurize. These two groups of cuts were separately combined, separately subjected to hydrodesulfurization, and thereafter the two desulphurized mixtures were

combined with the remaining cuts.

Example 5 illustrates an embodiment in which the catalytic cracked gasoline is distilled into two cuts i.e., a 30-100°C cut and a 100-230°C cut. Following analysis, the 100-230°C cut was found to have a high content of sulphur compounds as easy to desulphurize. This cut was subjected to hydrodesulfurization and then combined with the 300-100°C cut.

EP '126 does not disclose a process involving selective hydrogenation of a gasoline feedstock containing sulphur compounds, diolefins, olefins, aromatics, nitrogen and acetylenic compounds. Further EP '126 discloses separating a feedstock into a plurality of fraction which one fraction is rich in sulphur compounds that are characterized as hard to desulphurize whereas another fraction is rich in sulphur compounds that are easy to desulphurize. EP '126 does not disclose separating the feedstock to provide a light fraction that contains olefin from which substantially all the sulphur compounds have been removed, and a heavy fraction in which most of the sulphur compounds initially present within the gasoline feedstock are concentrated.

Similarly, EP '126 does not disclose a process wherein a stream is separated into four fractions, i.e., a light fraction, a heavy fraction and two intermediate fractions, and wherein one of the intermediate fractions is combined with a heavy fraction in which most of the initial sulphur compounds are concentrated, before that heavy fraction is contacted with a catalyst to at least partially decomposed or hydrogenate sulphur compounds. In EP '126, the combining together of fractions following the separation step occurs after the hydrodesulfurization procedure is performed. Compare Applicants' claims 16 and 20.

Thus, the process of EP '126 is complex involving analysis of the feedstock to decide how to perform the distillation and the analysis of the resultant cuts to decide which fractions are to be desulfurized. This is no motivation to modify the Carruthers et al. process so as to combine it with the complicated process of EP '126.

In any event, even if the disclosures of Carruthers et al. and EP '126 were combined as asserted, the resultant combination would not suggest Applicants' claimed invention. Neither reference, alone or in combination, discloses a feedstock containing nitrogen and acetylenic compounds. Nor does either reference disclose separating the effluent of a selective hydrogenation process into the light, heavy, and intermediate fractions recited in, for example,

Applicants' claims 1 and 46.

Further, neither reference suggests performing selective hydrogenation using a hydrogen/feedstock ratio of 8-30 liters/liter. Compare, e.g., Applicants' claim 1.

In view of the above remarks, it is respectfully submitted that Carruthers et al., taken alone or in combination with "EP '126, fails to render obvious Applicants' invention. Withdrawal of the rejection is respectfully requested.

**Rejection under 35 USC §103 in view of Carruthers et al., EP '126, and Cecil et al.**

Claims 13-15, 20, 26, and 27 are rejected as allegedly being obvious in view of Carruthers et al. (US 3,691,066), EP 0 725 126, and Cecil et al. (US 3,732,155). This rejection is also respectfully traversed.

The disclosure of Carruthers et al. and EP '126 are discussed above. Cecil et al. (US '155) describe a process wherein a hydrocarbon feed containing sulphur compounds is contacted with sulphur-resistant catalysts and progressively desulphurized in a combination of steps. In the initial step, the feed is contacted with catalysts while in the presence of hydrogen and thereby partially desulphurized. In a subsequent step, the feed is contacted with a catalyst, without hydrogen, and thereby desulphurized. See, Column 3, lines 1-11.

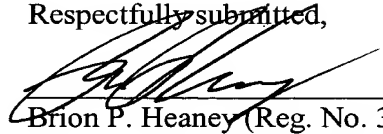
US '155 does not overcome the discrepancy in the disclosures of Carruthers et al. and EP '126, as discussed above. Nor is there any suggestion that the two-step desulphurization procedure described by US '155 would be suitable for use in treating the particular fractions obtained by EP '126, i.e., of either a fraction that is rich in sulphur compounds that are easy to desulphurize or a fraction that is rich in sulphur compounds that is hard to desulphurize.

US '155 makes no disclosure or suggestion that the described desulphurization process is useful in treating either of these two types of fractions. Thus, there is no motivation which would lead one of ordinary skill in the art to modify the hydrodesulphurization processes described in EP '126 by substituting therefore the two-step desulphurization process of US '155.

In view of the above remarks, it is respectfully submitted that Carruthers et al., taken alone or in combination with EP '126 and/or US '155, fails to render obvious Applicants' claimed invention. Withdrawal of the rejection under 35 U.S.C. §103 is respectfully requested.

The Commissioner is hereby authorized to charge any fees associated with this response or credit any overpayment to Deposit Account No. 13-3402.

Respectfully submitted,

  
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